

## CLAIMS

What is claimed is:

1     1.     A method of provisioning a device operable with internet protocol (IP) in a virtual  
2 circuit network, the method comprising the computer-implemented steps of:  
3         receiving a list of identifiers corresponding to virtual circuits from a configuration  
4             interface for the virtual circuit network; and  
5         iteratively applying each identifier to individual instances of interface configuration  
6             commands until connectivity with a remote device is established, comprising  
7             the steps of:  
8             obtaining an IP address for a device terminating the virtual circuit  
9             corresponding to an identifier selected from the list;  
10            determining an IP address for the device;  
11            testing the virtual circuit corresponding to the identifier selected from the list  
12            for connectivity with the remote device; and  
13            if the virtual circuit corresponding to the selected identifier provides  
14            connectivity to the remote device, then choosing the virtual circuit  
15            corresponding to the selected identifier for connecting to the remote  
16            device, otherwise, iteratively applying the above steps for a next  
17            identifier in the list until the list is exhausted.

1     2.     A method as recited in Claim 1, wherein the virtual circuit network comprises a frame  
2 relay network, and wherein the step of receiving a list of identifiers corresponding to virtual  
3 circuits from the configuration interface for the virtual circuit network further comprises:  
4         receiving a Local Management Interface (LMI) message comprising a list of at least  
5             one of a plurality of Data Link Connection Identifiers (DLCIs) in the network.

1     3.     A method as recited in Claim 1, wherein the virtual circuit network comprises an  
2 Asynchronous Transfer Method (ATM) relay network, and wherein the step of receiving a  
3 list of identifiers corresponding to virtual circuits from the configuration interface for the  
4 virtual circuit network further comprises:

5 receiving an Interim Local Management Interface (ILMI) message comprising a list  
6 of at least one of a plurality of Virtual Channel Identifiers or Virtual Path  
7 Identifiers (VCI/VPI) in the network.

1 4. A method as recited in Claim 1, wherein the step of iteratively applying each  
2 identifier to individual instances of interface configuration commands until connectivity with  
3 a remote device is established further comprises:

4 iteratively incorporating successive virtual circuit identifiers from the list into  
5 dynamically constructed commands to configure an interface to the virtual  
6 circuit network and successively applying the commands to the interface.

1 5. A method as recited in Claim 1, wherein the step of testing a virtual circuit  
2 corresponding to an identifier selected from the list for connectivity with a remote device  
3 further comprises the step of:

4 pinging a configuration server.

1 6. A method as recited in Claim 1, wherein the step of obtaining an IP address for the  
2 device terminating the virtual circuit corresponding to the selected identifier, further  
3 comprises:

4 forming an Inverse Address Resolution Protocol Request (IARP);  
5 sending the IARP request to a device terminating the virtual circuit; and  
6 receiving from the device terminating the virtual circuit an IP address.

1 7. A method as recited in Claim 1, wherein the step of determining an IP address for the  
2 device comprises the steps of:

3 determining a netmask for the device, wherein the subnet for the device is smaller  
4 than or equal to a subnet of the device terminating the virtual circuit  
5 corresponding to the selected identifier; and  
6 determining an IP address for the device valid in the subnet of the device based upon  
7 the address of the device terminating the virtual circuit.

1 8. A method as recited in Claim 7, wherein determining a netmask for the device and  
2 determining an IP address for the device valid in the subnet of the device based upon the  
3 address of the device terminating the virtual circuit corresponding to the selected identifier,  
4 further comprises the steps of:  
5 selecting a proposed netmask for a proposed subnet of smallest available size;  
6 testing if an IP address for the device terminating the virtual circuit corresponding to  
7 the selected identifier is valid within the proposed subnet;  
8 if the IP address for the device terminating the virtual circuit is valid within the  
9 proposed subnet, then performing the following steps:  
10 adding 1 to the IP address of the device terminating the virtual circuit  
11 to form a first result, and testing whether the first result is a  
12 valid address;  
13 if the first result is a valid address, choosing the first result as the IP  
14 address for the device, otherwise, subtracting 1 from the IP  
15 address of the device terminating the virtual circuit to form a  
16 second result and choosing the second result as the IP address  
17 for the device;  
18 otherwise, increasing the size of the proposed subnet and iteratively perform the  
19 above steps beginning with the testing step.

1 9. A method as recited in Claim 7, wherein determining a netmask for the device and  
2 determining an IP address for the device valid in the subnet of the device and based upon the  
3 address of a device terminating the virtual circuit corresponding to the selected identifier,  
4 further comprises the steps of:  
5 determining a largest netmask less than or equal to 30 bits (255.255.255.252) such  
6 that  $((ip\_address\_of\_the\_device\_terminating\_VC \& \sim netmask) \neq 0) \&\&$   
7  $((ip\_address\_of\_the\_device\_terminating\_the\ VC \mid netmask) \neq \sim 0)$  is true;  
8 adding 1 to the IP address of the device terminating the virtual circuit to form a first  
9 result, and testing whether the first result is a valid address in the netmask;

10 if the first result is a valid address, choosing the first result as the IP address for the  
11 device, otherwise, subtracting 1 from the IP address of the device  
12 terminating the virtual circuit to form a second result and choosing the  
13 second result as the IP address for the device.

1 10. A method as recited in Claim 1, further comprising the step of:  
2 automatically communicating an inventory of all interfaces associated with the device  
3 to the remote device upon establishing connectivity with the remote device.

1 11. A method of provisioning a device operable with internet protocol (IP) in a virtual  
2 circuit network, the method comprising the computer-implemented steps of:  
3 receiving a Local Management Interface (LMI) message comprising a list of at least  
4 one of a plurality of Data Link Connection Identifiers (DLCIs) in the network;  
5 iteratively applying each identifier to individual instances of interface configuration  
6 commands until connectivity with a remote device is established, comprising  
7 the steps of:  
8 obtaining an IP address for a device terminating the virtual circuit, further  
9 comprising the steps of:  
10 forming an Inverse Address Resolution Protocol (IARP) request;  
11 sending the IARP request to device terminating the virtual circuit;  
12 receiving from the device terminating the virtual circuit an IP address;  
13 determining an IP address for the device, further comprising the steps of:  
14 selecting a proposed netmask for a proposed subnet of smallest  
15 available size;  
16 testing if the IP address of the device terminating the virtual circuit is  
17 valid within the proposed subnet;  
18 if the IP address of the device terminating the virtual circuit is valid  
19 within the proposed subnet, then performing the following  
20 steps:  
21 adding 1 to the IP address of the device terminating the virtual  
22 circuit to form a first result, and testing whether the first  
23 result is a valid address;

24 if the first result is a valid address, choosing the first result as  
25 the IP address for the device, otherwise, subtracting 1  
26 from the IP address of the device terminating the virtual  
27 circuit to form a second result and choosing the second  
28 result as the IP address for the device;  
29 otherwise, increasing the size of the proposed subnet and iteratively  
30 performing the above steps for the next identifier in the list  
31 until the list is exhausted; and  
32 automatically communicating an inventory of all interfaces associated with the device  
33 to the remote device upon establishing connectivity with the remote device.

1 12. A computer-readable medium carrying one or more sequences of instructions for  
2 provisioning a device operable with internet protocol (IP) in a virtual circuit network, which  
3 instructions, when executed by one or more processors, cause the one or more processors to  
4 carry out the steps of:  
5 receiving a list of identifiers corresponding to virtual circuits from a configuration  
6 interface for the virtual circuit network; and  
7 iteratively applying each identifier to individual instances of interface configuration  
8 commands until connectivity with a remote device is established, comprising  
9 the steps of:  
10 obtaining an IP address for a device terminating the virtual circuit  
11 corresponding to an identifier selected from the list;  
12 determining an IP address for the device;  
13 testing the virtual circuit corresponding to the identifier selected from the list  
14 for connectivity with the remote device; and  
15 if the virtual circuit corresponding to the selected identifier provides  
16 connectivity to the remote device, then choosing the virtual  
17 circuit corresponding to the selected identifier for connecting to  
18 the remote device, otherwise, iteratively applying the above  
19 steps for a next identifier in the list until the list is exhausted.

1 13. A computer-readable medium as recited in Claim 12, wherein the virtual circuit  
2 network comprises a frame relay network, and wherein the instructions for carrying out the  
3 step of receiving a list of identifiers corresponding to virtual circuits from the configuration  
4 interface for the virtual circuit network further comprise instructions for carrying out the step  
5 of:

6 receiving a Local Management Interface (LMI) message comprising a list of at least  
7 one of a plurality of Data Link Connection Identifiers (DLCIs) in the network.

1 14. A computer-readable medium as recited in Claim 12, wherein the virtual circuit  
2 network comprises an Asynchronous Transfer Method (ATM) relay network, and wherein  
3 the instructions for carrying out the step of receiving a list of identifiers corresponding to  
4 virtual circuits from the configuration interface for the virtual circuit network further  
5 comprise instructions for carrying out the step of:

6 receiving an Interim Local Management Interface (ILMI) message comprising a list  
7 of at least one of a plurality of Virtual Channel Identifiers or Virtual Path  
8 Identifiers (VCI/VPI) in the network.

1 15. A computer-readable medium as recited in Claim 12, wherein the instructions for  
2 carrying out the step of iteratively applying each identifier to individual instances of interface  
3 configuration commands until connectivity with a remote device is established further  
4 comprise instructions for carrying out the step of:

5 iteratively incorporating successive virtual circuit identifiers from the list into  
6 dynamically constructed commands to configure an interface to the virtual  
7 circuit network and successively applying the commands to the interface.

1 16. A computer-readable medium as recited in Claim 12, wherein the instructions for  
2 carrying out the step of testing a virtual circuit corresponding to an identifier selected from  
3 the list for connectivity with a remote device further comprise instructions for carrying out  
4 the step of:

5 pinging a configuration server.

1 17. A computer-readable medium as recited in Claim 12, wherein the instructions for  
2 carrying out the step of obtaining an IP address for the device terminating the virtual circuit  
3 corresponding to an identifier selected from the list, comprises instructions for carrying out  
4 the steps of:

5 forming an Inverse Address Resolution Protocol Request (IARP);  
6 sending the IARP request to a device terminating the virtual circuit; and  
7 receiving from the device terminating the virtual circuit an IP address.

1 18. A computer-readable medium as recited in Claim 12, wherein the instructions for  
2 carrying out the step of determining an IP address for the device comprise instructions for  
3 carrying out the step of:

4 determining a netmask for the device, wherein the subnet for the device is smaller  
5 than or equal to a subnet of the device terminating the virtual circuit  
6 corresponding to the selected identifier; and  
7 determining an IP address for the device valid in the subnet of the device and based  
8 upon the address of the a device terminating the virtual circuit.

1 19. A computer-readable medium as recited in Claim 18, wherein the instructions for  
2 carrying out the step of determining a netmask for the device and determining an IP address  
3 for the device valid in the subnet of the device and based upon the address of the device  
4 terminating the virtual circuit, further comprise instructions for carrying out the steps of:

5 selecting a proposed netmask for a proposed subnet of smallest available size;  
6 testing if an IP address for the device terminating the virtual circuit corresponding to  
7 the selected identifier is valid within the proposed subnet;  
8 if the IP address for the device terminating the virtual circuit is valid within the  
9 proposed subnet, then performing the following steps:  
10 adding 1 to the IP address of the device terminating the virtual circuit  
11 to form a first result, and testing whether the first result is a  
12 valid address;

13                   if the first result is a valid address, choosing the first result as the IP  
14                   address for the device, otherwise, subtracting 1 from the IP  
15                   address of the device terminating the virtual circuit to form a  
16                   second result and choosing the second result as the IP address  
17                   for the device;  
18       otherwise, increasing the size of the proposed subnet and iteratively perform the  
19       above steps beginning with the testing step.

1   20.    A computer-readable medium as recited in Claim 19, wherein the instructions for  
2   carrying out the steps of determining an IP address for the device valid in the subnet of the  
3   device based upon the address the device terminating the virtual circuit and determining a  
4   subnet for the device, further comprise instructions for carrying out the steps of:  
5       determining a largest netmask less than or equal to 30 bits (255.255.255.252) such  
6       that ((ip\_address\_of\_the\_device\_terminating\_VC & ~netmask) != 0) &&  
7       ((ip\_address\_of\_the\_device\_terminating\_the\_VC | netmask) != ~0) is true;  
8       adding 1 to the IP address of the device terminating the virtual circuit to form a first  
9       result, and testing whether the first result is a valid address;  
10      if the first result is a valid address, choosing the first result as the IP address for the  
11      device, otherwise, subtracting 1 from the IP address of the device terminating  
12      the virtual circuit to form a second result and choosing the second result is the  
13      IP address for the device.

1   21.    A computer-readable medium as recited in Claim 12, further comprising instructions,  
2   which, when executed by the one or more processors, cause the one or more processors to  
3   carry out the step of:  
4       automatically communicating an inventory of all interfaces associated with the device  
5       to the remote device upon establishing connectivity with the remote device.

1   22.    An apparatus for provisioning a device operable with internet protocol (IP) in a  
2   virtual circuit network, comprising:  
3       means for receiving a list of identifiers corresponding to virtual circuits from a  
4       configuration interface for the virtual circuit network;



5 means for iteratively applying each identifier to individual instances of interface  
6 configuration commands until connectivity with a remote device is  
7 established, the means further comprising:  
8 means for obtaining an IP address for a device terminating the virtual  
9 circuit corresponding to an identifier selected from the list;  
10 means for determining an IP address for the device for use with the  
11 virtual circuit corresponding to the selected identifier providing  
12 connectivity to the remote device;  
13 means for testing a virtual circuit corresponding to the identifier  
14 selected from the list for connectivity with the remote device.

1 23. An apparatus method as recited in Claim 22, wherein the virtual circuit network  
2 comprises a frame relay network, and wherein the means for receiving a list of identifiers  
3 corresponding to virtual circuits from the configuration interface for the virtual circuit  
4 network further comprises:

5 means for receiving a Local Management Interface (LMI) message comprising a list  
6 of at least one of a plurality of Data Link Connection Identifiers (DLCIs) in  
7 the network.

1 24. An apparatus as recited in Claim 22, wherein the virtual circuit network comprises an  
2 Asynchronous Transfer Method (ATM) relay network, and wherein the means for receiving a  
3 list of identifiers corresponding to virtual circuits from the configuration interface for the  
4 virtual circuit network further comprises:

5 means for receiving an Interim Local Management Interface (ILMI) message  
6 comprising a list of at least one of a plurality of Virtual Channel Identifiers or  
7 Virtual Path Identifiers (VCI/VPI) in the network.

1 25. An apparatus as recited in Claim 22, wherein the means for iteratively applying each  
2 identifier to individual instances of interface configuration commands until connectivity with  
3 a remote device is established further comprises:

4 means for iteratively incorporating successive virtual circuit identifiers from the list  
5 into dynamically constructed commands to configure an interface to the  
6 virtual circuit network and successively applying the commands to the  
7 interface.

1 26. An apparatus as recited in Claim 22, wherein the means for testing a virtual circuit  
2 corresponding to an identifier selected from the list for connectivity with a remote device  
3 further comprises:

4 means for pinging a configuration server.

1 27. An apparatus as recited in Claim 22, wherein the means for obtaining an IP address  
2 for the device terminating the virtual circuit corresponding to the selected identifier, further  
3 comprises:

4 means for forming an Inverse Address Resolution Protocol Request (IARP);  
5 means for sending the IARP request to a device terminating the virtual circuit; and  
6 means for receiving from the device terminating the virtual circuit an IP address.

1 28. An apparatus as recited in Claim 22, wherein the means for determining an IP address  
2 for the device comprises:

3 means for determining a netmask for the device, wherein the subnet for the device is  
4 smaller than or equal to a subnet of the device terminating the virtual circuit  
5 corresponding to the selected identifier; and

6 means for determining an IP address for the device valid in the subnet of the device  
7 based upon the address of the device terminating the virtual circuit  
8 corresponding to the selected identifier.

1 29. An apparatus as recited in Claim 22, wherein the means for determining a subnet for  
2 the device and means for determining an IP address for the device valid in the subnet of the  
3 device and based upon the address of the device terminating the virtual circuit corresponding  
4 to the selected identifier, further comprise:

5 means for selecting a proposed netmask for a proposed subnet of smallest available  
6 size;

7 means for testing if the IP address of the device terminating the virtual circuit is valid  
8 within the proposed subnet;  
9 means for adding 1 to the IP address of the device terminating the virtual circuit to  
10 form a first result, if the IP address of device terminating the virtual circuit is  
11 valid within the proposed subnet, and testing whether the first result is a valid  
12 address;  
13 means for choosing the first result as the IP address for the device if the first result of  
14 adding 1 to the IP address of the device terminating the virtual circuit is a  
15 valid address, otherwise, subtracting 1 from the IP address of the device  
16 terminating the virtual circuit to form a second result and choosing the second  
17 result as the IP address for the device; and  
18 means for iteratively invoking the above means beginning with the means for testing.

1 30. An apparatus for provisioning a device operable with internet protocol (IP) in a  
2 virtual circuit network, comprising:  
3 a network interface that is coupled to the virtual circuit network for receiving one or more  
4 packet flows via switched virtual circuits therefrom;  
5 a processor;  
6 one or more stored sequences of instructions which, when executed by the processor, cause  
7 the processor to carry out the steps of:  
8 receiving a list of identifiers corresponding to virtual circuits from a configuration  
9 interface for the virtual circuit network; and  
10 iteratively applying each identifier to individual instances of interface configuration  
11 commands until connectivity with a remote device is established, comprising  
12 the steps of:  
13 obtaining an IP address for a device terminating the virtual circuit  
14 corresponding to an identifier selected from the list;  
15 determining an IP address for the device;  
16 testing the virtual circuit corresponding to the identifier selected from the list  
17 for connectivity with the remote device; and

18                   if the virtual circuit corresponding to the selected identifier provides  
19                   connectivity to the remote device, then choosing the virtual circuit  
20                   corresponding to the selected identifier for connecting to the remote  
21                   device, otherwise, iteratively applying the above steps for a next  
22                   identifier in the list until the list is exhausted.

1    31.    An apparatus as recited in Claim 30, wherein the virtual circuit network comprises a  
2    frame relay network, and wherein the instructions for carrying out the step of receiving a list  
3    of identifiers corresponding to virtual circuits from the configuration interface for the virtual  
4    circuit network further comprises instructions for carrying out the steps of:

5            receiving a Local Management Interface (LMI) message comprising a list of at least  
6            one of a plurality of Data Link Connection Identifiers (DLCIs) in the network.

1    32.    An apparatus as recited in Claim 30, wherein the virtual circuit network comprises an  
2    Asynchronous Transfer Method (ATM) relay network, and wherein the instructions for  
3    carrying out the step of receiving a list of identifiers corresponding to virtual circuits from  
4    the configuration interface for the virtual circuit network further comprises instructions for  
5    carrying out the step of:

6            receiving an Interim Local Management Interface (ILMI) message comprising a list  
7            of at least one of a plurality of Virtual Channel Identifiers or Virtual Path  
8            Identifiers (VCI/VPI) in the network.

1    33.    An apparatus as recited in Claim 30, wherein the instructions for carrying out the step  
2    of iteratively applying each identifier to individual instances of interface configuration  
3    commands until connectivity with a remote device is established further comprises  
4    instructions for carrying out the step of:

5            iteratively incorporating successive virtual circuit identifiers from the list into  
6            dynamically constructed commands to configure an interface to the virtual  
7            circuit network and successively applying the commands to the interface.

1    34.    An apparatus as recited in Claim 30, wherein the instructions for carrying out the step  
2    of testing a virtual circuit corresponding to an identifier selected from the list for connectivity  
3    with a remote device further comprises instructions for carrying out the step of:

4           pinging a configuration server.

1   35.    An apparatus as recited in Claim 30, wherein the instructions for carrying out the step  
2   of obtaining an IP address for the device terminating the virtual circuit corresponding to the  
3   selected identifier, further comprises:

4           forming an Inverse Address Resolution Protocol Request (IARP);  
5           sending the IARP request to a device terminating the virtual circuit; and  
6           receiving from the device terminating the virtual circuit an IP address.

1   36.    An apparatus as recited in Claim 30, wherein the instructions for carrying out the step  
2   of determining an IP address for the device comprises instructions for carrying out the steps  
3   of:

4           determining a netmask for the device, wherein the subnet for the device is smaller  
5                    than or equal to a subnet of the device terminating the virtual circuit  
6                    corresponding to the selected identifier; and  
7           determining an IP address for the device valid in the subnet of the device and based  
8                    upon the address of the device terminating the virtual circuit.

1   37.    An apparatus as recited in Claim 36, wherein the instructions for carrying out the step  
2   of determining a netmask for the device and the instructions for carrying out the step of  
3   determining an IP address for the device valid in the subnet of the device and based upon the  
4   address of the device terminating the virtual circuit corresponding to the selected identifier,  
5   further comprises the steps of:

6           selecting a proposed netmask for a proposed subnet of smallest available size;  
7           testing if an IP address for the device terminating the virtual circuit corresponding to  
8                    the selected identifier is valid within the proposed subnet;  
9           if the IP address for the device terminating the virtual circuit is valid within the  
10                  proposed subnet, then performing the following steps:  
11                    adding 1 to the IP address of the device terminating the virtual circuit  
12                    to form a first result, and testing whether the first result is a  
13                    valid address;

14                   if the first result is a valid address, choosing the first result as the IP  
15                   address for the device, otherwise, subtracting 1 from the IP  
16                   address of the device terminating the virtual circuit to form a  
17                   second result and choosing the second result as the IP address  
18                   of the device,  
19       otherwise, increasing the size of the proposed subnet and iteratively perform the  
20       above steps beginning with the testing step.

1   38.     An apparatus as recited in Claim 36, wherein the instructions for carrying out the step  
2   of determining a netmask for the device and the instructions for carrying out the step of  
3   determining an IP address for the device valid in the subnet of the device and based upon the  
4   address of the device terminating the virtual circuit corresponding to the selected identifier,  
5   further comprises the steps of:  
6       determining a largest netmask less than or equal to 30 bits (255.255.255.252) such  
7       that ((ip\_address\_of\_the\_device\_terminating\_VC & ~netmask) != 0) &&  
8       ((ip\_address\_of\_the\_device\_terminating\_the\_VC | netmask) != ~0) is true;  
9       adding 1 to the IP address of the device terminating the virtual circuit to form a first  
10       result, and testing whether the first result is a valid address;  
11       if the first result is a valid address, choosing the first result as the IP address for the  
12       device, otherwise, subtracting 1 from the IP address of the device terminating  
13       the virtual circuit to form a second result and choosing the second result as  
14       the IP address of the device.

1   39.     An apparatus as recited in Claim 30, further comprising instructions for carrying out  
2   the step of:  
3       automatically communicating an inventory of all interfaces associated with the device  
4       to the remote device upon establishing connectivity with the remote device.